

Seminar/Talk

The LLAMA effect: phonon-induced dynamical lubricity in nanoscale liquid flows

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Friction at solid-liquid interfaces governs liquid transport at the nanoscale and sets the performance of nanofluidic systems, as membranes for desalination and osmotic energy harvesting. Yet, the understanding of its microscopic origins remains limited. Standard theoretical and numerical studies, that genuinely do not consider fluctuations of the solid material, fail for example to explain anomalously low friction measured experimentally in carbon nanotubes. Here, we develop a field theory of the solid-liquid interface that incorporates both classical and quantum fluctuations of the confining solid. We provide a dynamical analogue, for solid-liquid interfaces, of the structural lubricity between incommensurate solids: when the solid's phonons oscillate faster than the liquid molecules rearrange at the interface, they dynamically smooth out the surface corrugation and friction can be significantly reduced. Under strong confinement, the same mechanism applies symmetrically to the liquid: long-wavelength acoustic modes in the liquid itself can further suppress friction. Such a regime is expected in nanometre-wide carbon nanotubes, where it implies a strong dependence of the friction with the tube length, that has not been explored yet. Finally, our results suggests that driven phonon excitations opens a way towards frictionless nanofluidic transport.

Thursday, December 3, 2026 11:00am - 12:00pm
Moonstone Bldg / Ground floor / Seminar Room F (I24.EG.030f)

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